TECHNICAL MANUAL

INSTRUMENT CALIBRATION PROCEDURE

WIDE-BAND HIGH-GAIN PREAMPLIFIER

TEKTRONIX B, 53B, 53/54B,
OR LAVOIE LA-265-B

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Page No.	Change No.#	Page No.	Change No.#
Title	0		
A	0		
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13	0		

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CHANGE NO.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY

TABLE OF CONTENTS

Section		Page
1	Introduction and Description	1
2	Equipment Requirements	3
3	Preliminary Operations	4
4	Calibration Process	5
4.1	Attenuator Tests	5
4.2	Attenuator Compensation Tests	6
4.3	Input Capacitance Tests	8
4.4	Rise Time Tests	9
	Navy Calibration Checklist	13

ILLUSTRATIONS

Figure		Page
1	Typical Attenuator Compensation Displays	7
2	Rise Time Test Configuration	9
3	Typical Waveform Display	10

TABLES

Table		Page
1	Calibration Description	1

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the Tektronix B, 53B, 53/54B, or LAVOIE LA-265-B Wide-Band High-Gain Preamplifier. The instrument being calibrated will be herein referred to as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to the Metrology Engineering Center, Naval Plant Representative, Pomona, California.

1.3 This procedure includes tests of essential performance parameters only. Any malfunctions noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
Attenuator	Range: 0.005V/cm to 20V/cm in a 1, 2, 5 sequence Limit of error: ±3%	Tested by applying a known input voltage, and verifying that the amount of deflection produced for each setting is within tolerance.
Attenuator compensation	None	A pulse or square-wave signal applied to the TI input is observed for proper compensation at each input sensitivity switch setting.
Input capacitance	47 pfd	Tested by applying a pulse or square-wave signal to the TI input through a 10:1 probe and verifying that the pulse or square-wave display does not change appreciably when the input sensitivity is changed.

(Continued on page 2)

TI Characteristics	Performance Specifications	Test Method
Rise time	From 18 to 40 ns depending on the oscilloscope-TI combination used. (See step 1.4.)	A pulse applied to the TI input is observed on the oscilloscope CRT for peaking, then the rise time is measured between the 10% and 90% amplitude points.

1.4 The TI may be used with the oscilloscopes listed below. The bandwidth and rise time are dependent upon the TI and oscilloscope combination as follows:

Oscilloscope - TI Combination Used	Deflection Factor	Bandwidth	Rise Time
Tektronix 531A, 533A, 535A	50 mV/cm to 20 V/cm	DC to 14 MHz	25 ns
	5 mV/cm to 20 mV/cm	2 Hz to 10 MHz	35 ns
Tektronix 536	50 mV/cm to 20 V/cm	DC to 10 MHz	35 ns
	5 mV/cm to 20 mV/cm	2 Hz to 9 MHz	40 ns
Tektronix 543B, 544, 545, 545A, 545B, 546, 547, 547, 555, 556, 581A[a], 585A[a]; or LaVoie LA-265	50 mV/cm to 20 V/cm	DC to 20 MHz	18 ns
	5 mV/cm to 20 mV/cm	2 Hz to 12 MHz	30 ns
549, 551	50 mV/cm to 20 V/cm	DC to 18 MHz	20 ns
	5 mV/cm to 20 mV/cm	2 Hz to 12 MHz	30 ns

[a]When using the 581A or 585A oscilloscope the type 81A adapter is required.

SECTION 2

EQUIPMENT REQUIREMENTS[1]

NOTE

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. The selection of equipment other than that designated is the responsibility of the supervisor of the calibrating activity. Correct performance of alternate items should be verified by operational tests. All applicable equipment must bear evidence of current calibration.

Item	Minimum Use Specifications	Calibration Equipment
2.1 Oscilloscope	No substitute NOTE If possible, calibrate the TI with the oscilloscope with which it is normally used. It is suggested that the submitting activity's oscilloscope and preamplifiers be submitted concurrently for calibration.	Tektronix 530 Series, 540 Series, 550 Series; or 580 Series
2.2 Alternating voltage source	Frequency: 400 Hz Voltage Output: Variable from 15 mV to 85V peak-to-peak Limit of error: ±0.75% Distortion: 1% max.	Ballantine Model 421AU4
2.3 Pulse or square-wave generator		

(Continued on page 4)

[1]The instruments utilized in this procedure were selected from those known to be available at Department of Defense facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval by the Department of Defense for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in the procedure.

NOTE

This procedure provides for calibration of the TI attenuator compensation and input capacitance using either a pulse or a square-wave generator. Select either instrument and perform the applicable portions of the procedure.

Item	Minimum Use Specifications	Calibration Equipment
2.3.1 Pulse generator	Rise time: approx. 100 ns Pulse width: adjustable from 10 μs to 0.5 ms Amplitude: 50V peak into 50 ohms Repetition rate: 0 to 500 Hz Delay: 0.1 μs to 1.0 ms	E-H Labs 132A-8 with a 50-ohm ±5%, 2w, non-inductive terminating resistor
2.3.2 Square-wave generator	Rise time: approx. 100 ns Frequency: 2.5 to 40 kHz Output: 0 to 27V peak into 600 ohms	Hewlett-Packard 211A with a 600Ω ±5%, 2w, non-inductive terminating resistor
2.4 Probe	10:1 attenuation	Item 2.1 accessory
2.5 Pulse generator	Rise time: 2.5 ns max. Pulse width: 2 μs Amplitude: 175 mV into 50 ohms Pulse repetition rate: 100 kHz	Hewlett-Packard 213B (see the first note in subsection 4.4)
2.6 Attenuator	Attenuation: 0 to 12 dB in 1 dB steps Limit of error: ±2% Input and Output Impedance: 50 ohms	Hewlett-Packard C08-355C, 355C, or 355A
2.7 Load	500 ohms ±5%, 1w, non-inductive	Stock item

SECTION 3

PRELIMINARY OPERATIONS

3.1 Connect the TI to the deenergized oscilloscope.

3.2 Adjust the oscilloscope intensity control fully CCW.

3.3 Set all auxiliary equipment controls as necessary to avoid damage to the equipment and so that dangerous voltages will not be present on output terminals when power switches are turned on.

3.4 Set the TI controls as follows:

INPUT SELECTOR switch to	INPUT A AC
VOLTS/CM switch to	.05
VOLTS/CM VARIABLE control to	CALIBRATED
VERTICAL POSITION control to	midrange

3.5 Turn all power switches on, and allow sufficient time for the equipment to stabilize. (The TI requires fifteen minutes to warm up.)

SECTION 4

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action before proceeding.

4.1 ATTENUATOR TESTS

4.1.1 Set the alternating voltage source controls for 400 Hz peak-to-peak operation and minimum output voltage.

4.1.2 Connect the alternating voltage source output to the TI INPUT connector.

4.1.3 Set the alternating voltage source controls for an output of exactly 0.020 volts.

4.1.4 Set the oscilloscope controls for an internally synchronized sweep time of 1 ms/cm, and the stability and positioning controls for a stable, properly positioned display.

NOTE

The display should be dim and properly focused to obtain maximum resolution.

4.1.5 Set the TI VOLTS/CM switch to each setting listed below. At each setting, adjust the alternating voltage source output voltage for exactly 4 cm of vertical deflection on the oscilloscpe, and verify that the alternating voltage source output voltage is within the tolerance limits listed.

TI VOLTS/CM Switch	A. V. Source	
	Volts Nominal (Peak-to-Peak Volts)	Tolerance Limits (Peak-to-Peak Volts)
.005	0.020	0.0194 to 0.0206
.01	0.040	0.0388 to 0.0412
.02	0.080	0.0776 to 0.0824
.05	0.200	0.194 to 0.206
.1	0.400	0.388 to 0.412
.2	0.800	0.776 to 0.824
.5	2.00	1.94 to 2.06
1	4.00	3.88 to 4.12
2	8.00	7.76 to 8.24
5	20.0	19.4 to 20.6
10	40.0	38.8 to 41.2
20	80.0	77.6 to 82.4

4.1.6 Set the alternating voltage source controls for minimum output. and disconnect the test setup.

4.2 ATTENUATOR COMPENSATION TESTS

4.2.1 Set the TI VOLTS/CM switch to .1.

4.2.2 Set the pulse or square-wave generator (whichever is used) controls for the following conditions:

Pulse Generator

Output Amplitude, minimum

Pulse mode, single

Pulse width, 10 μs

Repetition rate, 500 pps

Polarity, negative

Square-Wave Generator

Output Amplitude, minimum

Frequency, 40 kHz

Symmetry, midrange

4.2.3 Set the oscilloscope controls for a calibrated sweep time of 5 μs/cm and for:

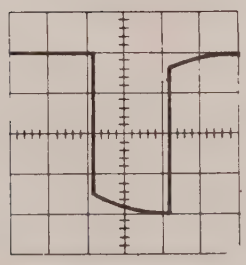
external triggering if a pulse generator is used;

internal triggering if a square-wave generator is used.

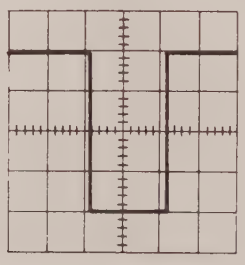
4.2.4 Connect the properly terminated pulse or square-wave generator output to the TI INPUT connector. Connect the terminating resistor as close as practicable to the TI INPUT connector.

4.2.5 If a pulse generator is being used, connect the trigger (or sync) output to the oscilloscope external trigger input.

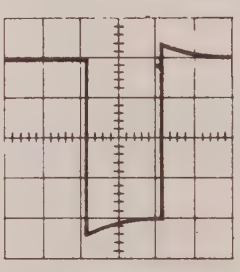
4.2.6 Set the TI VOLTS/CM switch to the .1, .2, .5, and 5 positions. At each setting, adjust the pulse or square-wave generator controls for a suitable vertical display, and verify that the display is properly compensated (See figure 1). Adjust the oscilloscope stability and positioning controls as necessary.



UNDERCOMPENSATED



CORRECT COMPENSATION



OVERCOMPENSATED

NOTE

The displays are based on a negative going input waveform. For positive inputs, the display will be inverted.

Figure 1. Typical Attenuator Compensation Displays

4.2.7 Adjust the pulse or square-wave generator controls for minimum output voltage, and disconnect the test setup.

4.3 INPUT CAPACITANCE TESTS

4.3.1 Set the TI VOLTS/CM switch to .005.

4.3.2 Set the pulse or square-wave generator (whichever is used) controls for the following conditions:

Pulse Generator

Output amplitude, minimum

Pulse mode, single

Pulse width, 0.4 ms

Repetition rate, 500 pps

Delay, approximately 0.8 ms

Rise time, approximately, 50 ns

Pulse polarity, negative

Square-Wave Generator

Output amplitude, minimum

Frequency, 1.2 kHz

Symmetry, midrange

4.3.3 Set the oscilloscope controls for a calibrated sweep time of 0.2 milliseconds/cm and for:

external triggering if a pulse generator is being used;

internal triggering if a square-wave generator is being used.

4.3.4 Connect the probe to the TI INPUT connector.

4.3.5 Connect the probe tip and probe ground lead to the properly terminated pulse or square-wave generator.

4.3.6 If a pulse generator is being used, connect the trigger (or sync) output to the oscilloscope external trigger input.

4.3.7 Adjust the pulse or square-wave generator amplitude controls for a 4 cm vertical display. Adjust the oscilloscope stability and positioning controls as necessary.

4.3.8 Adjust the probe capacitance for the squarest corners and flattest top possible on the display.

4.3.9 Set the TI VOLTS/CM switch to the .1, .2, .5, and 5 positions. At each setting, adjust the pulse or square-wave generator controls for a suitable vertical display, and verify that the display has a flat top and square corners.

4.3.10 Adjust the pulse or square-wave generator controls for minimum output voltage, and disconnect the test setup.

4.4 RISE TIME TESTS

NOTE

If a pulse generator other than a Hewlett-Packard 213B is used, the shape of the output pulse must be known. Also, the rise time of the pulse generator should be four times faster than the TI nominal rise time. If not, the actual TI rise time must be calculated using the following formula:

$$T_a = \sqrt{T_1^2 - t_2^2}$$

T_a = TI rise time

T_1 = observed rise time on the oscilloscope CRT

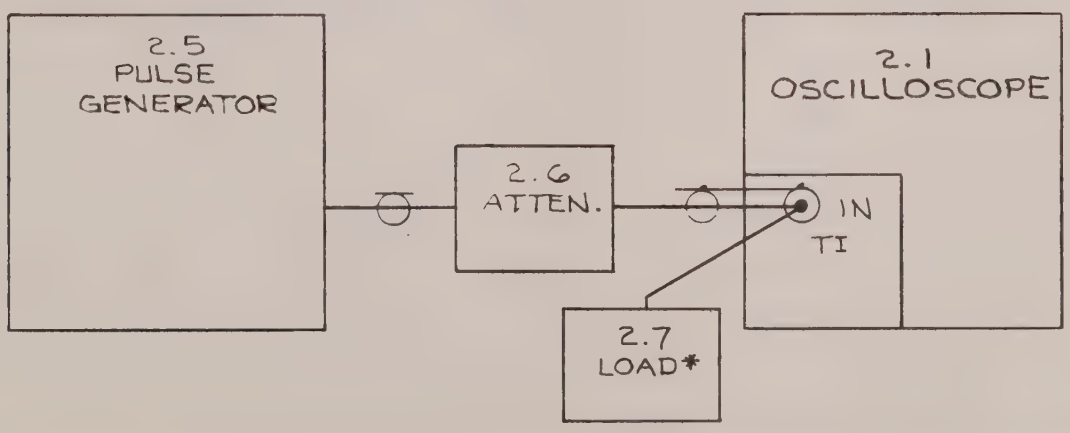
T_2 = known rise time of the pulse generator output pulse

4.4.1 Set the oscilloscope controls for an internally synchronized sweep time of 0.1 microseconds/cm.

4.4.2 Set the TI VOLTS/CM switch to .05.

4.4.3 Set the pulse generator controls for an output pulse approximately 2 microseconds wide, a pulse repetition rate of 100 kHz and minimum output voltage.

4.4.4 Connect the applicable equipment as shown in figure 2. Keep the connections as short as practicable.



*Connect as close as practicable the attenuator to the pulse generator and the load to the TI INPUT connector.

Figure 2. Rise Time Test Configuration

4.4.5 Set the attenuator for 1 dB.

4.4.6 Set the pulse generator, oscilloscope, and the TI controls for a stable display of suitable amplitude, centered on the CRT.

4.4.7 Verify that any peaking of the pulse leading edge does not exceed 5% of the total pulse amplitude.

4.4.8 Set the oscilloscope controls for a sweep time of 0.02 microseconds/cm by setting the sweep time to 0.1 microseconds/cm and turning the 5X magnifier ON.

4.4.9 If necessary, set the pulse generator, oscilloscope, and the controls for a stable, centered display. See figure 3.

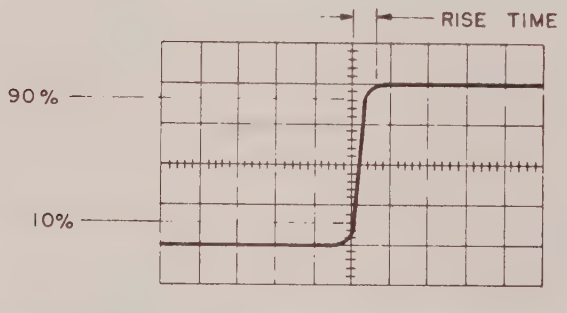


Figure 3. Typical Waveform Display

4.4.10 Measure the rise time of the pulse between the 10% and 90% amplitude points, and verify that the rise time is within tolerance.

Oscilloscope - TI Combination Used[a]	Tolerance
DC to 10 MHz	35 ns max.
DC to 14 MHz	25 ns max.
DC to 18 MHz	20 ns max.
DC to 20 MHz	18 ns max.

[a]See step 1.4, page 2.

4.4.11 Set the TI VOLTS/CM switch to .02, and set the attenuator control for 10 dB.

4.4.12 Turn the oscilloscope 5X magnifier off, then set the controls for an internally synchronized sweep time of .1 microseconds/cm.

4.4.13 Repeat steps 4.4.6 through 4.4.10, except verify that the rise time is within the tolerance listed below.

Oscilloscope - TI Combination Used[a]	Tolerance
2 Hz to 1 MHz	40 ns max.
2 Hz to 10 MHz	35 ns max.
2 Hz to 12 MHz	30 ns max.

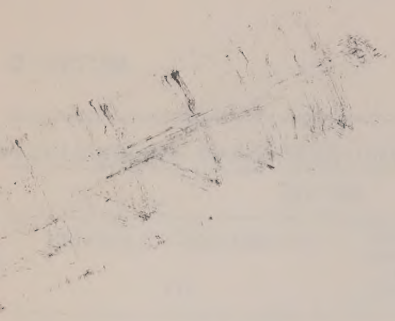
[a]See step 1.4, page 2.

4.4.13 Unless other measurements are to be performed, turn all power switches off, and disconnect the TI.

TEST INST (S): TEA B,53B,53/54B, or LaVoie LA-265-B Wide-Band High-Gain Preamplifier

PROC NO. NA17-20AA-04 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.1	Atten. Tests	(P-P V)				(Peak-to-Peak Volts)
4.1.5	Volts/cm sw. .005	0.020				0.0194 to 0.0206
"	" " .01	0.040				0.0388 to 0.0412
"	" " .02	0.080				0.0776 to 0.0824
"	" " .05	0.200				0.194 to 0.206
"	" " .1	0.400				0.388 to 0.412
"	" " .2	0.800				0.776 to 0.824
"	" " .5	2.00				1.94 to 2.06
"	" " 1	4.00				3.88 to 4.12
"	" " 2	8.00				7.76 to 8.24
"	" " 5	20.0				19.4 to 20.6
"	" " 10	40.0				38.8 to 41.2
"	" " 20	80.0				77.6 to 82.4
4.2.6	Atten. Comp.	--	ck ( )			properly compensated
4.3.9	INPUT cap. test	--	ck ( )			" "
4.4	Rise Time Tests Using a 10 MHz Oscilloscope - TI Combination.					
4.4.7	Pulse Shape (50 mV)	--	ck ( )			peaking: 5% max.
4.4.10	Rise time (50 mV)	--				35 ns max.
4.4.13	Pulse Shape (20 mV)	--	ck ( )			peaking: 5% max.
"	Rise time (20 mV)	--				40 ns max.
4.4	Rise Time Tests Using a 14 MHz Oscilloscope - TI Combination.					
4.4.7	Pulse shape (50 mV)	--	ck ( )			peaking: 5% max.
4.4.10	Rise time (50 mV)	--				25 ns max.
4.4.13	Pulse shape (20 mV)	--	ck ( )			Peaking: 5% max.
"	Rise time (20 mV)	--				35 ns max.
4.4	Rise time Tests Using a 18 MHz Oscilloscope - TI Combination					
4.4.7	Pulse shape (50 mV)	--	ck ( )			Peaking: 5% max.
4.4.10	Rise time (50 mV)	--				20 ns max.
4.4.13	Pulse shape (20 mV)	--	ck ( )			Peaking: 5% max.
"	Rise time (20 mV)	--				30 ns max.
4.4	Rise time Tests Using a 20 MHz Oscilloscope - TI Combination					
4.4.7	Pulse shape (50 mV)	--	ck ( )			Peaking: 5% max.
4.4.10	Rise time (50 mV)	--				18 ns max.
4.4.13	Pulse shape (20 mV)	--	ck ( )			Peaking: 5% max.
"	Rise time (20 mV)	--				30 ns max.



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